Role of the estuary in the recovery of Columbia River Basin salmon
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I. Introduction

- **A. Problem Statement**
  - **1. numerous salmon populations at risk**
  - **2. is there an intrinsic contribution of estuaries to salmon recovery – why is there a concern?**
  - **3. expression of contingent strategies a requirement for population resilience**
  - **4. estuaries subject to extensive urban use and anthropogenic modification, i.e. loss of estuarine habitat for many biological users, including salmon**
  - **5. In the abstract sense, under extreme conditions, absence of estuaries implies loss of estuarine dependent strategies**
- **B. Approach**
  - **1. use VSP as criteria for recovery**
  - **2. need to define diversity and spatial structure as it pertains to estuarine life history strategies**
  - **3. need to assess role of anthropogenic modification – land use patterns, flow, etc**
- **C. Landscape scale – what is the estuary**
  - **1. tidal freshwater zone**
  - **2. oligohaline/brackish water zone**
  - **3. plume**

II. Shifting perspectives, the historical approaches i.e., from production to current view – review of the literature

- **A. 'production', limiting factors, and 'bottlenecks' as a driving force**
- **B. Hydrologic changes – from SARE**
  - **1. climate**
  - **2. dams and irrigation**

III. Role of the estuary.

- **A. Conceptual model- rely on SARE but simplify the SARE model into a couple of pages.**
- **B. Diversity and spatial structure**
  - **1. Linking salmon contingent (LH) strategies in time and space**
    - **a. ocean vs stream type**
    - **b. fry, fingerling, riverine, estuarine, smolts, and juveniles**
  - . **2. What habitats are important to what LH types.**
    - **a. Is there a typical distribution pattern amongst LH strategies for ocean or stream - type salmon**
    - **b. develop table relating habitat to LH Type to potential ESU**
  - **3. Aspects/attributes of important habitats- focus at large scales (e.g., temp, depth, location in estuary, etc).**

C. Evidence from the CR – i.e., data.
- **1. Hump diagram.**
- **2. Genetic data**
- **3. Return to river.**

D. Evidence from other salmon populations.
- **1. Puget Sound**
- **2. Miller and Sadro**

E. Evidence from other organisms.
- **1. Striped bass.**
- **2. Rainbow trout**
- **3. Eelgrass**

F. Evidence of plume role and use
- **1. primary and secondary productivity**
- **2. association with fronts**
- **3. dispersal**
- **4. low salinity affinity**
- **5. growth enhancement and predator refuge**

IV. Methods of Assessment – how to assess the role of the estuary and development of decision making tools

A. Couple hydrologic model with habitat attributes (from SARE)

B. Habitat change analysis

C. Metrics for assessment – how to value the contribution of contingent strategies used by salmon
- **1. abundance or mortality/survival – direct valuation; limited**
- **2. linking contingent strategies to recruitment success**
- **3. Limitations and role**
- **4. Conduct at appropriate temporal and spatial scale**

V. What actions can be taken in the estuary and plume.

A. Effects of flow.

B. Restoration of habitat.

C. What are the opportunities for change in the estuary for each life history/ESU

D. Which life history/ESU would benefit from any scenario of actions taken in the estuary

VI. Conclusions.

System survival and transportation
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I. Introduction.

Discuss measured and perceived historical impacts of the hydropower system on juvenile and adult salmon, which will include citing many old papers, PATH documents, etc. to set the stage. Then discuss how this "Tech Memo" will provide a summary of the latest information available, including new analyses, summaries of papers in review, or just short summary statements of recent papers that we can cite. This will not include information specific to passage at each dam.

II. Methods

- A. Annual adult return estimates for chinook population as a whole and spawner to spawner estimates (Snake River Basin).
- B. PIT-tagged fish
  - i. Where and by whom marked - not random samples
  - ii. How to make juvenile survival estimates.
  - iii. SARs and how derived
- C. Flow/travel time and survival estimates
- D. Factors that influence SARs
- E. What fish and how to evaluate transportation
- F. How to compute D
- G. How to evaluate extra mortality

III. Results

- A. Trends in populations
- B. Juvenile survival estimates for downstream migrants passing through dams (total and by reach)
  - i. Head of Lower Granite Dam Reservoir to below Bonneville Dam
    - a. Yearling chinook
    - b. Subyearling chinook
    - c. Steelhead
  - ii As far up the upper Columbia R. and Yakima R. as possible to the tailrace of Bonneville Dam
    - a. Yearling chinook
    - b. Steelhead
- C. Juvenile survival estimates from release (or detection) from upstream of hydropower system through tailrace of Lower Granite Dam
- D. Timing to Lower Granite Dam versus flow and temperature
- E. SAR for smolts at LGR or upper most point possible in upper Columbia or Yakima R.
- F. Annual SAR for fish transported from LGR, LGO, LMO, and MCN
  - i. Based on fish marked at dams. Provide pros/cons reasons for using these estimates
  - ii. Based on fish marked above dams. Provide pros/cons reasons for using these

estimates

G. Annual “D” estimates

F. Temporal SAR

i. Transported fish

ii. Non-transported fish

iii.. “D” based on temporal variability

G. Spawner to spawner data over time

H. Extra mortality

IV. Discussion

Hypothesized mechanisms for results and variability

i. Timing of transported fish and how this might impact survival on ocean entry or readiness to enter seawater

ii. Timing of non-transported fish

iii. Differential guidance of transported and non-transported fish

vi. Stocks PIT-tagged and differential survival of them to LGR (may apply mostly to hatchery fish)

v. Effects of changing ocean conditions

vi. Diversity (related to VSP)

vii. Evidence for or against extra mortlaity

V. Conclusion/Summary

i. Readiness to enter seawater (?)

ii. Possibly other impacts on stock viability for which data analyses or discussion cover in more detail elsewhere - predation, habitat, hatcheries

Passage of Juvenile and Adult Salmonids
Past Columbia and Snake River Dams
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A review of the relative fitness of hatchery and natural-origin salmon

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